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TRACE ELEMENTS' POLLUTION ASSESSMENT IN VEGETABLES FROM IRRIGATION AREAS OF DADIN KOWA DAM, GOMBE STATE, NIGERIA

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ABSTRACT

Vegetables are part of a healthy and important diets to human being, but they could be contaminated in many ways: through irrigation, atmospheric deposit and some human activities. This work is aimed at assessing heavy metal concentrations in some vegetables in the irrigation area of Dadin Kowa Dam, Gombe State Nigeria. Energy Dispersive X-ray Fluorescence Spectroscopy (EDXRF) was used for the detection for spectral analysis. The vegetable samples were cultivated and harvested locally between October, 2019 to January, 2020. After which the edible vegetables (onion bulb and cabbage leaf) samples were harvested at maturity and collected along transect lines within the farms. The vegetable samples were prepared and taken to the laboratory for the analysis. The following metals mean concentrations were obtained in onion and cabbage samples respectively (Values in part per millions (ppm)): Mo (9.582 and 9.880), Zr(5.523 and 4.778), Sr(21.780 and 30.732), Rb(9.139 and 17.228), Zn(26.866 and 14.576), Cu(24.466 and NA), Fe(83.265 and 61.925), Ti(30.604 and 24.075), Ca(15752.460 and 2736.190), K(15076.784 and 29039.254), Ba(969067.123 and 961907.100) and Nb(10.512 and 9.929). The obtained results were interpreted using Transfer factor, Daily intake of metals and Geo-accumulation index. It was found out that in vegetables, the element with highest transfer factor (TF) observed in onion is Ca while Zr, Sr, Rb, Cu, Ti, Fe, and Nb had virtually less than one transfer factor. In the case of cabbage Zn happened to have the highest TF. Daily intake in onion, almost all the elements were below the tolerable limits of 77ppm except Nb which is within the limit 0.2 ppm as stated by FAO/WHO. In Geo-accumulation index, only Mo was extremely polluted because is greater than five Muller, (1969). Mo, Zr, Sr, Rb, Zn, Fe, Ti, and Cu were found to be below the reported standard limits. Ca, K and Ba in both vegetables were found to be higher than recommended limits but they are reported to be relatively harmless. Significant correlation was found for most of the elements determined. However, in vegetables, at $\alpha = 0.05$ some of the metals Fe with Cu, Ca with Zn have shown positive correlation while Zn with Rb and Ca with Rb, showed negative correlation. At $\alpha = 0.01$, K with Rb, Ti with Cu and Ti with Fe showed positive correlation while Ba with K are negatively correlated. The vegetables under study in Dadin Kowa Dam irrigation area showed relatively law state of pollution for most of the elements determined.

Keywords: Trace elements, pollution, EDXRF, vegetables, irrigation, Dadin Kowa Dam Area

INTRODUCTION

There is a growing concern about heavy metals contamination of food crops in world today. This is as results of toxicity and diseases in human and animals. Among the six classes of food with vitamins, vegetables are one of its examples. Vegetables are part of healthy and important diets to human being but, they could be contaminated in many ways, through irrigation, atmospheric deposits and some human activities. However, from contamination and toxicity points of view, that is contaminations of onion and cabbage with heavy metals are of major concerned in this work. Heavy metals are naturally occurring elements, and are present in varying concentrations in all ecosystems. They are found in elemental form and in chemical compounds. Each form or compound has a different property which also affects what happen to it in food web, and how toxic it may be.

Heavy metals have atomic densities higher than $4g/cm^3$, and these include lead (Pb), cadmium (Cd), zinc (Zn), mercury (Hg), arsenic (As), silver (Ag), chromium (Cr), copper (Cu), iron (Fe), and platinum (Pt). The high level of environmental contamination by these metals is dangerous because their uptake by plants and subsequent accumulation in food crops consumed by humans and animals is deleterious to health. Evidence shows that vegetables and other food crops consumed in Nigeria are contaminated by heavy metals, and this is associated with adverse health issues, such as cancer, which is currently on the rise in Nigeria (Onakpa *et al.,*2018).

However, in Dadin Kowa, Yamaltu-Deba Local Government Area Gombe State of Nigeria, the contamination of metals in vegetables has not been givenmore consideration. So, the assessment of heavy metals in soils and vegetables will not just give the health risk but also the assessment of environmental pollution. As many cases of high blood pressure, miscarriage, hepatitis and other related diseases could be as a result of taking large quantity of the heavy metals.

Consequently, the continuous consumption of such vegetables samples contaminated with toxic heavy metals exceeding the safe permissive limits may result in serious health problems. It is therefore vital to educate communities around the study area to avoid or monitor eating large quantities of these vegetables items with high levels of heavy metal pollution.

This work is aimed at assessing heavy metals concentrations in vegetables in the irrigation areas of Dadin Kowa Dam Gombe Sate, Nigeria.

MATERIALS AND METHODS

Description of the Study Area

Dadin Kowa Dam is located in Dadinkowa. A village in Yamaltu Deba Local Government Area of Gombe State in the North East of Nigeria, which is about 35 kilometres to the east of Gombe town. It provides drinking water for the neighboring villages and Gombe metropolis. The Dam was completed by the Federal Government of Nigeria in 1984, with the goal of providing irrigation and electricity for the planned Gongola sugar plantation project. The coordinates for the study area are 10° 19' 19" N, 11° 28' 54" E and has the total capacity of eight hundred million metre cube ($800,000,000\ m^3$). Tables 1 and 2 give the farms location with the referencing coordinates and sample codes with description respectively.

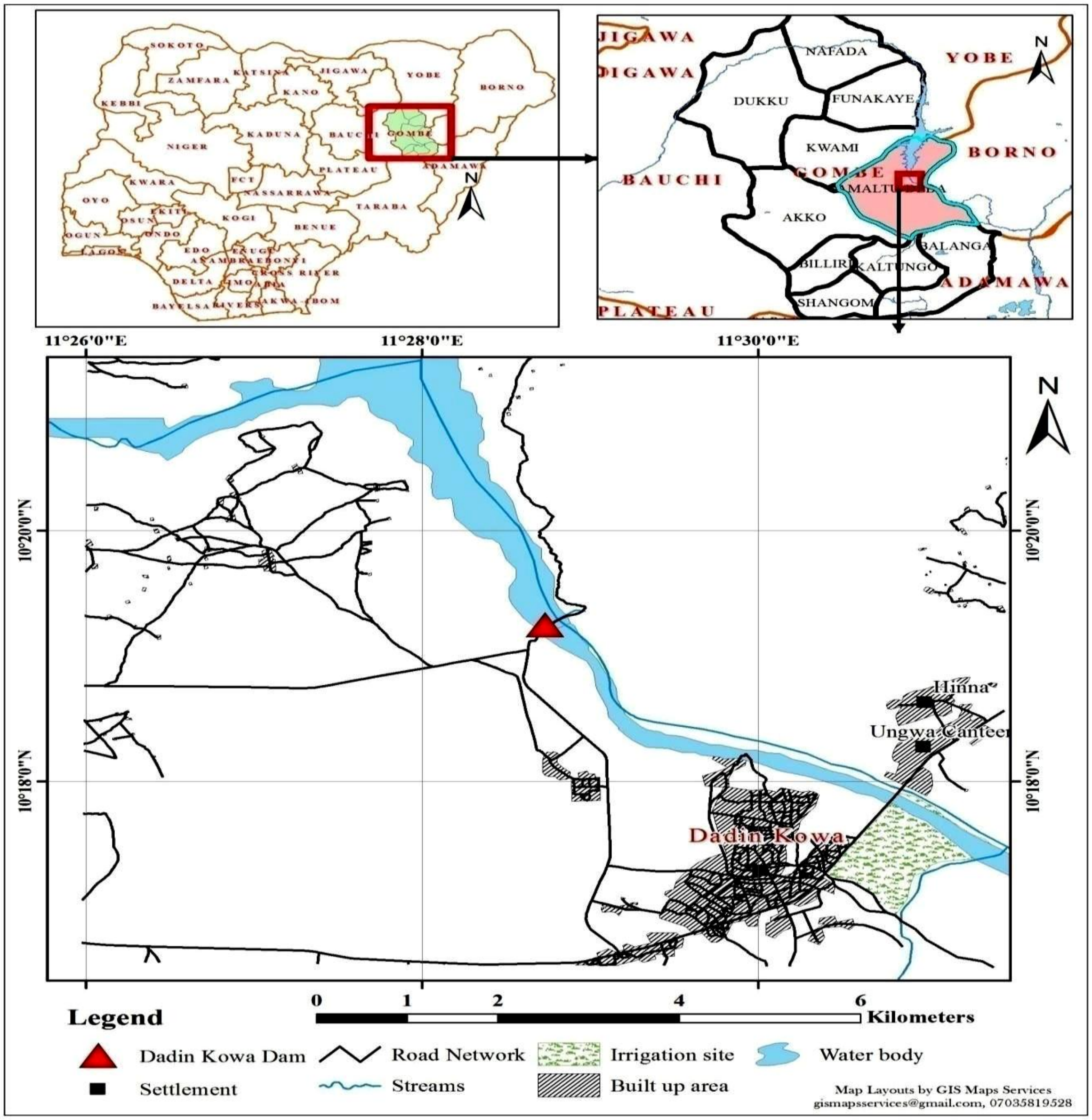

Figure 1: Map of the study area (GIS Maps Services Gombe) (Andrew,2021)

Table 1: Farms locations with their geo-referencing coordinates

S/N	Farm Locations	Latitude	Longitude	Altitude
1	Onion Farm	10° 17' 35.49" N	11°30' 40.60"E	210.12m
2	Cabbage Farm	10° 17' 50.19" N	11° 30' 43.9" E	210.25m

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Table 2: Sample codes and their descriptions

S/N	Sample Codes	Sample Codes Description
1	ONA	Onion Sample A
2	ONB	Onion Sample B
3	ONC	Onion Sample C
4	OND	Onion Soil Point D
5	ONE	Onion Sample E
6	CBA	Cabbage Sample A
7	CBB	Cabbage Sample B
8	CBC	Cabbage Sample C
9	CBD	Cabbage Sample D
10	CBE	Cabbage Sample E

Study Design/Procedure

The procedure adopted in this work involves Sample Collection, Preparation and Laboratory Analysis that is, assessment of heavy metal concentrations in edible vegetables samples from the irrigation area were carried out.

Sample Collection/Preparation

Vegetables Samples Collection and Preparation

Vegetables were collected along transect (Melville and Welsh,2001). This was done for the vegetables planted in the irrigation area. The following edible vegetables (onion and cabbage), five samples of the onion bulb were collected / harvested at maturity (Two months after planting seedlings) and five samples of the cabbage leaf were also harvested (Two months after planting seedlings), packed into clean polythene bags for laboratory analysis. In preparation, soil particles were washed off from the samples. Then cut it in to small pieces and air dried at the room temperature for two weeks and then pounded into powder. Then the samples were collected in a labeled polythene bags and were taken to the laboratory for the analysis (Ebong *et al.,* 2008; Faithfull, 2002)

Assessment of Heavy Metals Concentrations in Soils and Vegetables Samples

Heavy metals in soils and vegetables samples were determined using energy dispersive x-ray Fluorescence Spectroscopy (EDXRF) system in the laboratory.

Samples were collected from the site taking into consideration the possibility of future changes in the samples, example washing the sample properly and putting it into good container before taking it to the laboratory for preparation.

Data Analysis and Evaluation

The trend distribution of the elements was assessed by various statistical analysis tools after determining the heavy metals in the vegetables samples collected from the study sites. The pollution indices and statistical analysis includes: Transfer Factor, Daily Intake of Metals (DIM) and Geo-Accumulation Factor. The statistical software SPSS (Statistical Package for Social Science) was used to obtain a descriptive interpretation of the Pearson correlation of the elements found in the vegetables.

Transfer Factor for vegetables

Transfer factor was calculated in other to found out the heavy metals accumulation by the onion and cabbage samples from the soil. The risk and associated hazard due to ingestion, consequent upon the heavy metals accumulation in vegetables was also assessed. The computed transfer factor for each heavy metal was based on the Harrison and Chirgawi, (1989) method. The heavy metal transfer from soil is expressed as:

$$Transfer\ factor = \frac{\text{Metal content in vegetable}}{\text{Metal content in soil}} \quad (1)$$

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Daily Intake of Metals (DIM)

Daily intake of metal (DIM) as reported by Cui *et al.,* 2004 is given by:

$DIM = \boldsymbol{C}metal \times \boldsymbol{D}vegetable\ intake$ (2)

In equation above, $C_{metal,}$ and $D_{vegetableintake}$, stand for the heavy metal concentration in vegetables and daily intake of vegetables respectively. The required amount of vegetables for human is 77g/day(GEMS/Food,2000)

The Geo Accumulation Index

The Geo Accumulation Index characterized surface soil from unpolluted to extremely polluted. Geo Accumulation Index (I_{geo}) was originally defined by Muller, (1969) as:

$I_{geo} = [C_s/(1.5\times C_b)]$ (3)

where, C_s is the measured concentration of the examined heavy metal in sample, 1.5 is the background matrix correction due to terrigenous effect or is introduced tominimize the effect possible variations in the background and C_b is the geochemical background concentration or reference value of the metal or background value of the heavy metal in the uncontaminated sample. The classification of the I_{geo} as reported by Hankouraou and Jibrin, 2020 is given in Table 3 below.

Table 3: Geo Accumulation Index and Pollution Category (Hankouraou and Jibrin,2020)

Geo accumulation index	Pollution
$I_{geo} \leq 0$	Unpolluted
$0 < I_{geo} \leq 1$	Unpolluted/Moderately
$1 < I_{geo} \leq 2$	Moderately
$2 < I_{geo} \leq 3$	Moderately/Heavily
$3 < I_{geo} \leq 4$	Heavily/Extremely
$4 < I_{geo} \leq 5$	Extremely

Correlation Analysis

The measure of similarity between paired data is termed correlation analysis. The degree of inter relation between variables can be estimated with the help of correlation coefficient (r) without any influence by measurement units. Correlation is the ratio of covariance (joint variation of two variables about their common mean) of two variables to the product of the standard deviation (Davis, 1973; Hankouraou, 1998).

Correlation Coefficient being a ratio is a dimensionless number and covariance may equal but can never exceed the product of the standard deviation of its variables. Correlation ranges from +1 to -1. A correlation of +1 is an indication of a perfect direct relationship between two variables. While that of -1 indicates that one variable changes inversely in relationship to the other. A spectrum of less than perfect relationship lies between the two extremes including zero which indicates the lack of any linear relationship.

RESULTS AND DISCUSSION

The following heavy metals (Mo, Zr, Sr, Rb, Zn, Cu, Fe, Mn, Ti, Sc, Ca, K, S, Ba, and Nb) and their concentrations were obtained from the comprehensive analysis of vegetables using EDXRF. But for the purpose of this work only the following elements were considered. Those elements include: Mo, Zr, Sr, Rb, Zn, Fe, Cu, Ti, Ca, K, Ba and Nb. The concentrations of all trace elements in the vegetables are as shown in Tables 4 and 5

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Table 4: Trace elements in onion samples and their concentrations in ppm

Elements	ONA	ONB	ONC	OND	ONE
Mo	9.182	9.826	10.855	9.837	8.750
Zr	5.575	5.693	5.740	7.070	3.537
Sr	16.509	19.753	23.612	19.876	29.149
Rb	12.134	9.428	6.858	6.750	10.524
Zn	17.886	23.630	20.982	23.691	48.143
Cu	N/A	N/A	24.466	N/A	N/A
Fe	83.288	30.287	153.925	95.293	53.531
Ti	N/A	N/A	43.176	18.032	N/A
Sc	20.408	28.433	24.339	N/A	49.058
Ca	13680.116	12956.624	21897.883	10189.387	20038.293
K	12448.591	16014.697	22369.688	11315.257	13235.689
S	4200.362	4759.738	5501.454	2744.848	3701.413
Ba	973801.563	970982.375	955487.000	978419.875	966648.250
Nb	10.303	11.993	12.405	9.942	7.918

NA= not available

Table 5: Trace element in cabbage samples and their Concentrations in ppm

Elements	CBA	CBB	CBC	CBD	CBE
Mo	9.711	10.136	10.464	11.447	7.642
Zr	4.332	4.762	4.881	5.111	4.806
Sr	62.562	30.004	20.504	17.906	22.684
Rb	16.064	25.252	10.695	22.369	11.761
Zn	9.673	15.903	20.035	13.371	13.899
Cu	N/A	N/A	N/A	N/A	N/A
Fe	N/A	59.254	69.421	71.525	47.502
Ti	N/A	N/A	N/A	21.075	N/A
Sc	24.437	N/A	N/A	N/A	N/A
Ca	4492.805	3014.897	1159.452	2690.389	2323.405
K	27837.217	32125.467	18413.564	38732.691	28087.330
S	3885.527	3562.927	1769.986	3882.943	3105.882
Ba	962101.125	960082.625	978192.063	953357.563	965802.125
Nb	9.135	12.529	8.048	10.832	9.101

NA = not available

Table 6: Mean concentrations ± SD of trace elements in vegetables samples (Values in ppm)

Elements	Mean for Onion	Mean for Cabbage
Mo	9.582 ± 0.79671	9.880 ± 1.40376
Zr	5.523 ± 1.26925	4.778 ± 0.28736
Sr	21.780 ± 4.82523	30.732 ± 18.35461
Rb	9.139 ± 4.50916	17.228 ± 6.41751
Zn	26.866 ± 12.12977	14.576 ± 3.79181
Cu	24.466 ± 11.138	NA
Fe	83.265 ± 46.980	61.925 ± 29.289
Ti	30.604 ± 18.974	21.075 ± 9.425
Ca	15752.460 ± 4979.801	2736.190± 1206.438
K	15076.784 ±4430.357	29039.254 ± 734.995
Ba	969067.123 ±8715.328	961907.100 ± 9176.494
Nb	10.512 ± 1.79403	9.929 ± 1.76278

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NA = not available

The mean concentrations of the trace elements determined in both sample are reported in Table 6 above. The results are discussed in terms of Transfer Factor (TFs), Metal Daily Intake (MDI), Geo accumulation Index (Igeo) and Correlation Coefficient.

The metals concentrations transfer factor from the farms soils to their individual

harvested vegetables were calculated and the results were as shows in Table 7

Table 7: Transfer Factor (TF) for vegetables

Elements	Transfer Factor for Onion	Transfer Factor for Cabbage
Mo	1.169	1.109
Zr	0.013	0.011
Sr	0.107	0.353
Rb	0.192	0.405
Zn	3.043	14.043
Fe	1.932×10^{-03}	1.994×10^{-03}
Cu	0.290	NA
Ti	5.08×10^{-03}	2.96×10^{-03}
Ca	4.702	2.138
K	3.201	9.161
Ba	1.038	1.002
Nb	0.400	0.398

NA = not available

In Table 7, the elements with highest transfer factor observed in Onion were Ba, Ca and K while Zr, Sr, Rb, Cu, Ti, Fe, and Nb had virtually less than one transfer factor. In the case of Cabbage transfer factor, Zn happened to have the highest TF. This could be as a result of the contamination from the external sources of pollutants such as fertilizers and pesticides which are important inputs in agricultural production. Nevertheless, the long-term excessive application has resulted in the heavy metal contamination of soils. The vast majority of pesticides are organic compounds, and a few are organic - inorganic compound or pure mineral, and some pesticides contain Hg, As, Cu, Zn and other heavy metals (Adamu *et al.,*2010).

The required daily intake for vegetables as stated is 77g/day (GEMS/Food, 2000). The metals daily intakes were calculated for Mo, Zr, Sr, Rb, Zn, Cu, Fe, Nb, Ti, Ca, K, and Ba concentrations in onion and cabbage separately. The results are as shown in Table 8 below.

Table 8: Metal Daily Intake(MDI)for vegetables (Values in mg/day)

Elements	Daily Intake for Onion	Daily Intake for Cabbage	Cumulative DI
Mo	0.738	0.761	1.499
Zr	0.425	0.368	0.791
Sr	1.677	2.366	4.043
Rb	0.701	1.327	2.028
Zn	2.069	1.096	3.191
Fe	6.411	4.768	11.179
Cu	0.00032	NA	0.00032
Ti	23.780	1.623	25.403
Ca	1212.943	210.687	1423.63
K	1160.912	2236.022	3396.934
Ba	74618.169	74066.847	148685.016
Nb	0.809	0.765	1.574

It is clearly shown that Ba has the highest daily intake values are 74618.2 mg in onion sample and 74066.9 mg in cabbage sample, although K and Ca also have high concentrations but are reported to be relatively harmless(Seydou,1998)

Geo accumulation Index (I_{geo}) for vegetables samples was calculated as defined earlier. The results were shown in Table 9 below. The geo accumulation index of the vegetables (onion and cabbage) and almost all the elements in both onion and cabbage were found to be greater than zero but less than one. So we can conclude that, they were Unpolluted/Moderately. Except K in cabbage which is greater than one but less than two, so it was moderately polluted. Mo was extremely polluted because is greater

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than five so, is more terrifying Muller, (1969).

Table 9: Geo accumulation Index (I_{geo}) for vegetables

Elements	I_{geo} for Onion	I_{geo} for Cabbage
Mo	14.8558	15.3178
Zr	0.0227	0.0197
Sr	0.0378	0.0534
Rb	0.0781	0.1473
Nb	0.3504	0.3310
Fe	0.0009	0.00053
Cu	0.0593	NA
Zn	0.2357	0.1279
Ti	0.0013	0.00045
Ca	0.2254	0.0391
K	0.5463	1.0522

NA = not available

The Pearson's Correlation matrices among the studied metals (Mo, Zr, Sr, Rb, Zn, Cu, Fe, Ti, Ca, K, Ba, and Nb) in vegetables samples were determined and the values are shown in Table 10. At α = 0.05, some of the metals such as Fe with Cu and Ca with Zn showed significant positive correlation between each other, while, Zn with Rb and Ca with Rb, has significant negative correlation between them. At α = 0.01, K with Rb, Ti with Cu and Ti with Fe showed the existence of positive correlation for each pair of metals. It is important to note that Ba with K was negatively correlated. The obtained results here show that the complexes of some elements within the soil strata could be influenced by the presence of other given elements (Seydou ,1998)

Table 10: Person's correlation matrices between variable parameters in vegetables

	Mo	Zr	Sr	Rb	Zn	Cu	Fe	Ti	Ca	K	Ba	Nb
Mo	1											
Zr	0.274	1										
Sr	-0.075	-0.471	1									
Rb	0.382	-0.053	0.161	1								
Zn	-0.248	-0.267	-0.201	-0.745*	1							
Cu	0.346	0.218	-0.069	-0.247	0.009	1						
Fe	0.367	0.509	-0.565	-0.24	0.117	0.751*	1					
Ti	0.569	0.469	-0.226	-0.11	-0.064	0.833**	0.811**	1				
Ca	-0.051	0.104	-0.156	-0.708*	0.658*	0.58	0.485	0.418	1			
K	0.333	-0.298	0.249	0.806**	-0.6	0.012	-0.177	0.138	-0.587	1		
Ba	-0.349	0.334	-0.265	-0.456	0.237	-0.436	-0.104	-0.456	-0.033	-.787**	1	
Nb	0.452	0.441	-0.204	0.425	-0.324	0.45	0.356	0.452	0.183	0.285	-0.455	1

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2tailed).

In Table 11 above it can observed that the concentrations of Mo, Sr, and Rb in onion samples were found to be lower than the corresponding obtained values in cabbage, while Zr, Zn, Fe and Nb had higher concentrations in cabbage, Cu was only available in onion.

Molybdenum concentration in onion and cabbage samples at different sampling points range from 8.750 to10.855ppm and 7.642 to 11.447ppm respectively which are below the required level. Permissive limit for Molybdenum in vegetables (onions and cabbage) is 40ppm as given by by FAO/WHO. High concentration of this element can cause headache, fatigue, loss of appetite, muscle and join pain. It may also raise the uric acid in the body which can lead to gout and may damage kidneys and liver (Ugonna, 2020).

Table 11: Comparison of this work values for vegetables with FAO/WHO (Values in ppm or as stated)

Elements	Values for Onion	Values for Cabbage	FAO/WHO
Mo	9.582	9.880	40
Zr	5.523	4.778	71
Sr	21.780	30.732	74
Rb	9.139	17.228	375
Zn	26.866	14.576	100
Cu	4.893	N/A	73.3
Fe(%)	0.008	0.005	0.043
Ti(%)	0.001	0.0004	-
Ca(%)	1.575	0.274	0.008
K(%)	1.508	2.904	0.011
Ba(%)	96.907	96.191	0.050
Nb	10.512	9.929	0.2

NA= not available

Zirconium is found in both onion and cabbage and at all sampling points. The concentration of zirconium in onion ranges from 3.537 to 7.07ppm and 4.332 to 5.111ppm in cabbage. And this is below the recommended level stated by WHO for both vegetables (WHO,2001).

The concentration of Strontium from all sampling points in both onion and cabbage ranges from 16.509 to 29.149ppm and 17.906 to 62.562ppm respectively. Which are also below the FAO/WHO baseline standard of 74ppm (FAO/WHO,2002)

In onion Rubidium concentration ranges from 6.75 to 12.134ppm while in cabbage 10.524 to 25.252ppm which are below the standard level of 375ppm as reported by FAO/WHO,2002

Concentrations of Zn in all the vegetables (onion and cabbage) were found to be below required limit. 99.4 ppm for vegetables (WHO, 2001). Zn has many benefits, among which include essential co-factor for a large number of enzymes in human body. But, excessive zinc intake may have harmful effects such as vomiting, stomach pain, and diarrhea etc. (Yusuf and Seydou, 2019)

Cupper (Cu), is known as an important nutrient in our body when it does not exceed the allowable limit but, when took in a large quantity it can damage kidney, liver and bone marrow, causes anaemia developmental toxicity (Brewer, 2010). FAO/WHO (2001) gave maximum permissive limit for Cu as 73.3 ppm and EU standard 140ppm. Copper is found only in onion sample at sampling point C with concentration of 24.466 ppm which is below limit and not detected in cabbage samples at all.

Concentrations of Fe in onion and cabbage samples are within the range 30.287 to 153.925ppm and 47.502 to 71.525ppm respectively. Which is below the baseline level of 425.5ppm given by FAO/WHO (2003), however high concentration of ion (Fe) may lead to tissue damage as a result of the formation of free radical in the body (Yusuf and Seydou, 2019)

In onion and cabbage, the concentration of Niobium at different sampling points ranges from 8.048 to 12.529 and 7.918 to 12.405ppm respectively. Which were all above the required limits of 0.2ppm stated by FAO/WHO (2003).

For potassium in onion and cabbage the concentration ranges from 11315.257to 16014.697 ppm and 18413.564 to 38732.691 ppm respectively. Which were all above the recommended limits of 0.2ppm given FAO/WHO (2002)

Barium is found in both onion and cabbage and at all sampling points.

The concentration of zirconium in onions ranges from 955487.000 to 978419.875 ppm and 953357.563 to 978192.063 ppm in cabbage. And this is above the recommended level stated by WHO for both vegetables (WHO,2001).

The concentration of Titanium in onion ranges from 18.032 to 43.176 ppm and 000 to 21.075 ppm in cabbage. These values are above the recommended level set by WHO (2001) for vegetables.

The Calcium concentration in onion ranges from 10189.387 to 21897.883ppm while in cabbage it is from 1159.452 to 4492.805ppm which are above the FAO/WHO standard level (FAO/WHO,2003)

CONCLUSION

The results obtained show that both onion and cabbage grown from the study area have heavy metals of environmental concern. The element with highest transfer factor observed in Onion was Ca, while, Zr, Sr, Rb, Cu, Ti, Fe, and Nb had virtually less than one transfer factor. In the case of Cabbage transfer factor, Zn happened to have the highest Transfer Factor, though it was not detected in its farm soil somewhere else. This could be as a result of the contamination from the external sources of pollutants.

Daily Metal Intake clearly shows that the contamination level of the analyzed vegetables samples was discovered to be within the tolerable limits. Except Ca, K, Ba and Nb which are found to be above maximum tolerable limits. This might be as the result of the longtime application of pollutants such as fertilizer, pesticides, herbicides etc. during the irrigation farming which may lead to the contamination of soil. Though relatively harmless, but long-term metal exposure by regular consumption of such locally grown vegetables with such elements in high concentration may pose potential health problems to animal and humans. Therefore, close monitoring of the irrigation area is necessary based on our findings even though most the concentrations obtained are within the tolerable limits sat by international reported organization such us WHO and FAO.

REFERENCES

Andrew Adamu (2021): determination of Heavy Metals Concentration in Soils and Vegetables in the Irrigation Area of Dadin Kowa Dam, Gombe State Nigeria, Unpublished M.Sc. Dissertation, Department of Physics Gombe State University.

Davis, J. C. (1973): Statistic and Data Analysis in Geology; John Wiley and Sons, New York. 550

Ebong, G. A., Akpan, M. M. N. (2008): Heavy metal contents of municipal and rural dumpsite soils and rate of accumulation by Carica papaya and Talinum triangulare in Uyo, Nigeria. *E-Journal of Chemistry*, Vol. 5, pp 281-290.

Faithfull, N. T. (2002): Methods in agricultural chemical analysis: a practical handbook.

DOI: 10.56892/bima.v6i03.64

FAO/WHO (2001): Food additives and contaminants, Joint Codex Alimentarius Commission, FAO/WHO. Food standards Programme, ALINORM 01/12A.

FAO/WHO (2002): Codex Alimentarius-general standards for contaminants and toxins in food. Schedule1 Maximum and guideline levels for contaminants and toxins in food, Joint FAO/WHO food standards programme.Rotterdam:Codex committee;Reference CX/FAC 02/16.

GEMS/Food, (2000): Regional Diets prepared by Global Environmental monitoring system /food contamination monitoring and Assessment programme (GEMS/FOOD).

Hankouraou S. and Jibrin S. (2020): Determination of Heavy Metals' Pollution from Motor Parks' Soils of Gombe Metropolis, Nigeria. *Bima Journal of Science and Technology, Vol. 4(1), pp324-33.*

Hankouraou, S., and Yusuf, M. A. (2019): Determination of Concentrations of some Heavy Metals in Cow Fresh Milk. *Journal of the Nigerian Association of Mathematical Physics. Vol.53, pp 123 – 130*

Harrison, R. M., and Chirgawi, M. B. (1989): The assessment of air and soil as contributors of some trace metals to vegetable plants. *Science of the Total Environment*, 83(1-2), 13-34.

Melville, G. J. and Welsh, A. H. (2001): Line transect sampling in small regions.

Muller, W.P. and Mcfree, W.W. (1969): Distribution of Cd, Zn, Cu and Pb in soils ofindustrial Northwestern India. *Journal of Environmental Quality*, 12, 29-33.

Onakpa M. M., Njan A. A., and Kalu O. C. (2018): *A Review of Heavy Metal Contamination of Food Crops in Nigeria. Annals of Global Health*. 2018; 84(3), pp. 488–494.

Seydou, H. (1998). Determination of Trace Elements in Kubanni River Sediment Using Energy Dispersive X-ray Fluorescence Techniques: Unpublished MSc Thesis in Department of Physics Ahmadu Bello University Zaria.

Ugonna C. Nkwunonwo, Precious O. *Hindawi*. *The Scientific World Journal Volume 2020*, Article ID 6594109, 11 pages

WHO(2001):Food additives and contaminant. Joint FAO/WHO. ALINORM 01/12A: 1-28.